Adapting GPS Technology for TDRS Orbit Determination

RADIO METRIC TRACKING

Steve Lichten

A new approach for tracking and performing orbit determination for NASA's Tracking and Data Relay Satellites (TDRS) is being studied at JPL and evaluated by NASA, Goddard Space Flight Center and by the Aerospace Corporation. The determination of TDRS orbits is a near-real time task which is necessary in order to provide navigation support to TDRS users at low-Earth altitude.

TDRS users currently include military as well as non-military spacecraft. While the current system for TDRS orbit determination, called the Bilateral Ranging Transponder System (BRTS), is meeting its requirements, NASA is studying several other ways to maintain continuous knowledge of the TDRS orbits.

The hope is that some of the alternative system will incorporate new technology, which in turn will lead to lower operational costs and better services for TDRS customers. The BRTS network involves operation and maintenance of a global network of transponder sites, and requires that TDRS user time be set aside in order for the BRTS observations to be scheduled.

JPL's new approach exploits extremely precise timing and atmospheric information available from the Global Positioning System (GPS). JPL exploratory analyses done several years ago suggested that GPS ground terminals, with minor modifications, could simultaneously track GPS signals along with the carrier phase on the space-to-ground link from TDRS. By incorporating the GPS timing and other calibrations, which JPL has shown can be done routinely in an automated processing system, studies indicated that only 3 or 4 of these modified GPS receivers deployed in the vicinity of the White Sands TDRS tracking site in New Mexico could probably meet all of the TDRS orbit determination requirements. Since the modified GPS receivers could all be within a few hundred kilometers (and possibly within 40 km) of White Sands, operation and maintenance of the GPS/TDRS network would become essentially a localized operation, with most data acquisition and orbit determination functions nearly completely automated. This could lead to a new era of lowered operations costs for TDRS, with the added advantage that the new system would not interfere at all with user time on TDRS.

An experiment in January 1994 showed that single-day solutions with the new GPS/TDRS approach were capable of ~25-m quality orbits. That experiment, which lasted about one week, showed that the carrier phase data from TDRS, when combined with GPS data and with a small amount of White Sands range data (these range data are routinely collected), had the basic strength to meet current TDRS requirements (50 meters) and also provide potential for improvement to meet possible future tighter requirements. JPL has now prepared a plan for a fast-track approach to reaching the point of implementation readiness.

The plan includes demonstration of automated TDRS processing, including maneuvers, and development of a prototype system which would minimize implementation costs. Whether NASA proceeds with the new GPS-based innovative scheme for TDRS orbit determination depends on an evaluation presently being carried out by the Aerospace Corporation, NASA, and by GSFC.

The determination of TDRS orbits is a near-real time task which is necessary in order to provide navigation support to TDRS users at low-Earth altitude.

CONTINUED FROM PAGE 1

Systems Analysis, managed by Fabrizio Pollara of Section 331; (2) Spacecraft Communications Systems, managed by Lance Riley of Section 336; and (3) Flight Demos. At the present time, we are working on four flight demos: SURFSAT, managed by Steve Johnson of Section 317; Ka-band Antenna Performance (KaAP), managed by Dave Morabito of Section 339; Low-Earth Orbiter Demonstration (LEO-D), managed by Nasser Golshan of Section 339; and KaBLE II, managed by Stan Butman of Section 339.

The DSN Technology Program is managed by Chad Edwards with deputies Laif Swanson and Charles Stelzried.

THIS ISSUE

The ***DSN Technology Program News*** will keep you informed about what's going on in some of these work areas. For instance, Mike Thorburn's Antenna Systems work area has developed new techniques for some of the harder problems associated with receiving at Ka-band (32 gHz). And Jim Shell's Low-Noise Systems work area needs to be able to test the HEMTs at temperatures lower than the commercial world cares about, so they've developed a cryogenic probe station.

The DSN's frequency standards (hydrogen masers) are extremely accurate and extremely hard to deal with, but the new Linear Ion Trap Standards being developed by John Dick's Frequency and Timing work area are just as accurate and getting better, and they're not nearly so finicky.

Randy Hill's Network Automation work area is developing automated procedures to take the place of the extremely operator intensive work of running a station pass. And Nasser Golshan's LEO-D program has demonstrated that a low-Earth orbiter can be tracked by a "station" which consists of one inexpensive antenna and a terminal based on a SPARC-10.

We hope you enjoy reading about these developments in the DSN Technology Program. And, if you have comments about the newsletter or about the contents of our program, please contact Laif Swanson at 3-3090, or send email to *laif@shannon.jpl.nasa.gov* or contact Chad Edwards at 4-4408, or *chad.edwards@jpl.nasa.gov*

The *DSN Technology Program News* is a quarterly publication of JPL's Deep Space Network Technology Program Office.

Managing Editor .... Dr. Laif Swanson
Associate Editor .... George E. Shultz
Design and Layout .... Robin Dumas

JPL
Jet Propulsion Laboratory
California Institute of Technology

JPL D-12378